DRAFT CONCEPT
White Paper

Watershed Development Districts
&
Impervious Cover Thresholds

Department of Planning & Land Use
Watershed Planning Program
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The County of San Diego acknowledges the contributions made by Mr. Jerry Kauffman and the researchers with the Water Resources Agency at the University of Delaware, Institute for Public Administration on the topic of impervious cover thresholds. When developing this White Paper, the County of San Diego relied heavily on the Water Resources Agency's abstract paper entitled: The Role of Impervious Cover as a Watershed Zoning and Land Use Planning Tool in the Christina River Basin of Delaware.

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Executive Summary

WATER QUALITY DATA is the most definitive measure of determining the quality of our watersheds. However, presently, water quality information for the watersheds is not readily available, nor is it expected to be in the foreseeable future. Absent this information, mapping impervious surface coverage may be the next best option municipalities have at measuring stream water quality and watershed health.

National research over the last decade shows an increasingly significant correlation between impervious surface coverage and water quality. Development generally results in an increase in both pollutant sources and impervious surfaces. The increase in pollutant sources (i.e. the land uses that generate pollutants), such as parking lots, buildings/rooftops and streets, contribute to increased pollutant loads found in stormwater runoff. Development exponentially compounds its negative impacts on water quality because the increase in impervious surfaces prevents the land's natural ability to filter the same pollutant loads out of the stormwater runoff and provide infiltration. As a result, developed areas vastly increase stormwater runoff volumes and the pollutant quantities carried in the runoff.

Mapping impervious surface coverage can help land use professionals better assess the quality of the entire watershed, as well as provide assistance in guiding growth patterns to minimize impacts on stream water quality. Below summarizes three ways this information can help the Department of Planning and Land Use and the County.

- Watershed Development Districts. The Department of Planning and Land Use is considering the use of impervious surface coverage as a measurable indicator to guide development in the sensitive sub-watersheds of San Diego County. Once impervious surfaces are mapped and analyzed, the Department could consider developing "watershed development districts" that would establish maximum percent impervious surface thresholds for new and redevelopment projects. This White Paper details the rational, concept and case study for this project.

- Assessment of GP2020. One of the environmental factors that must be analyzed in the Environmental Impact Report for GP2020 is water quality and flooding. Impervious surface mapping can be a powerful tool to assess the level of impact GP2020 will have on water quality at plan build-out.

- Jurisdictional URMP Reporting. The Municipal Stormwater Permit requires, in part, that jurisdictions modify their planning process to more directly address water quality. By mapping the impervious surface of the current General Plan at build out and comparing it to the mapping of the impervious surface of GP2020 at build out, the County could show the Regional Water Quality Control Board how land use planning can positively impact water quality.

An accurate impervious surface map starts with accurate impervious cover coefficients. Unfortunately, most impervious cover coefficients are based upon studies conducted in the mid-west and east cost. Since development patterns and land use philosophies in San Diego differ significantly from the Midwest, east coast and even other southern California cities, coefficients unique to the county are required to more accurately reflect the impervious cover in our region.

The Department of Planning and Land Use GIS research product entitled "Mapping Impervious Surfaces in the Upper San Diego River Watershed," provides the starting point for estimating the average proportion of hardscape in the San Diego River watershed. However, the study was only conducted for single-family residential land use categories located within a small segment of the San Diego River Watershed. In order for the impervious surface coefficients to be statistically significant and representative of the entire watershed, the study area needs to be expanded to include sample areas within the incorporated cities as well as rural unincorporated county.

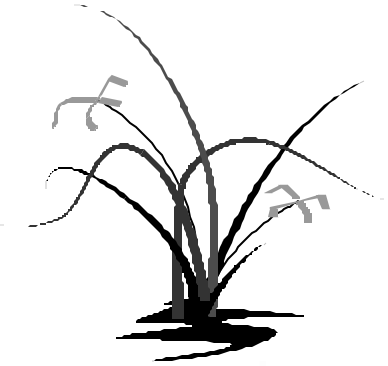
The Department of Planning and Land proposes to expand the GIS project to make the impervious surface coefficients scientifically significant so we can apply the information to the three projects mentioned above. However, the project requires $37,000 to complete, and the department lacks significant funding to cover this expense (a breakdown of this cost can be found in Table 6-1 of the White Paper). As such, the Department of Planning and Land is seeking one-time funding to finance this valuable project.

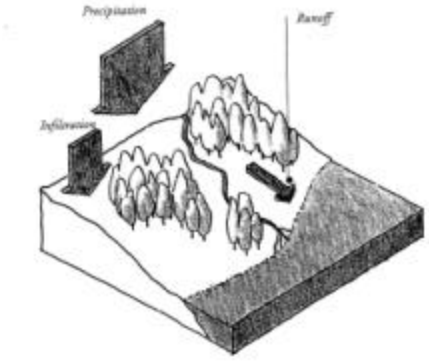
1.0 Introduction

FOR BOTH ENVIRONMENTAL AND ECONOMIC REASONS, San Diego County has become a highly desirable location to live in southern California. Subsequently, urban centers in San Diego County have expanded dramatically within the last 20 years. This rapid conversion of open or agricultural landscapes to a built environment of urban and suburban features has often been followed with a commensurate increase in impervious cover.

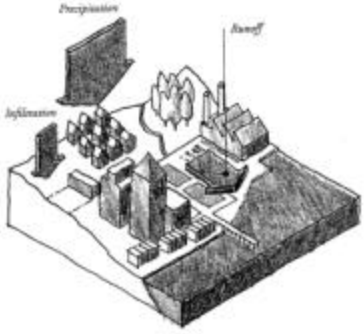
National research over the last decade shows an increasingly significant correlation between impervious surface coverage and water quality. Development generally results in an increase in pollutant sources and impervious surfaces. The increase in pollutant sources (i.e. the land uses that generate pollutants), such as parking lots, buildings/rooftops and streets, contribute to increased pollutant loads found in stormwater. Development exponentially compounds its negative impacts on water quality because the increase in impervious surfaces prevents the land's natural ability to filter the same pollutant loads out of the stormwater runoff and infiltrate into the soil (Figure 1-1). What is the end result? Developed areas vastly increase stormwater runoff volumes and the pollutant quantities carried in the runoff. Not surprisingly, these stormwater flows from urban areas – urban runoff – impair the quality of downstream receiving waters (creeks, streams, rivers, bays and ocean).

Figure 1-1: Hydrologic Cycle [1]





Pre-Development



Post Development

[1] Start at the Source. 1999

Land use professionals frequently struggle with the problems of uncontrolled growth and sprawl and their adverse impacts on water quality. Furthermore, as water quality issues do not follow jurisdictional boundaries, coordinating municipal development programs and practices on a watershed scale is extremely challenging. Fortunately, tools such as watershed management and impervious cover thresholds are available to address these problems. Researchers with the Water Resources Agency at the University of Delaware, recommend an approach to protect water supplies and contain sprawl through land use planning based on natural hydrological boundaries – the watersheds. Impervious cover thresholds can be used to focus growth into Watershed Development Districts where development would have the least impact on stream water quality.

This White Paper discusses the following facets of a plan to implement impervious cover thresholds for land and water planning at the watershed level in San Diego.

- Technical Basis For Impervious Cover Thresholds
- Impervious Cover Thresholds – The Concept
- The San Diego River – A Case Study
- Implementation Tool

2.0 Technical Basis For Impervious Cover Thresholds

BUILDINGS, ROADS, SIDEWALKS AND OTHER IMPERVIOUS SURFACES have necessary functions in modern society and they define the urban and suburban landscape. However, too many buildings and roads in a particular watershed can have adverse effects on water resources and stream water quality. Impervious surfaces alter the natural hydrology, prevent the infiltration of water into the ground and concentrate the flow of stormwater over the landscape. In undeveloped watersheds, stormwater filters down to the soil, replenishing the groundwater quantity with water of good quality. Vegetation holds down soil, slows the flow of stormwater over land and filters out some of the pollutants by both the slowing of the flow of water and trapping some pollutants in the root system. As the impervious area of a watershed increases, the greater the volume of stormwater increases the possibility of flooding and reduces the potential for pollutants to settle out; meaning that more pollution is delivered to drinking water systems and aquifers. Too much paving and hardening of a watershed can reduce infiltration and groundwater levels which in turn can decrease the availability of aquifers, streams and rivers for drinking water supplies.

2.1 The Correlation Between Impervious Surface Coverage and Water Quality

National research over the last decade shows an increasingly significant correlation between impervious surface coverage and water quality:

- Research by the Delaware Department of Natural Resources and Environmental Control indicates that biological habitat and macron invertebrate insect diversity dropped sharply at 19 nontidal streams in the Piedmont Province of Delaware when the impervious surface coverage in a watershed exceeded 8 to 15 percent imperviousness. [2]

- A strong negative relationship has been found between biotic integrity and increasing land use and riparian conditions, which begin at 10 percent imperviousness. [3]

- The Article "Site Planning for Urban Stream Protection", by the Center for Watershed Protection cites research conducted in many geographic areas has yielded a conclusion that stream degradation occurs at relatively low levels of imperviousness of 10 to 20 percent. [4]

- Research done in Maryland found that macroinvertebrate diversity declines above 10 percent imperviousness. [5]

[2] Shaver and Maxted, J.R. 1995
[3] Booth, as cited in Schueler, Thomas. 1997
[4] Schueler, Thomas. 1995
[5] Schueler and Galli, 1992

- In Maryland, the abundance and recruitment of brown trout declines sharply 10 percent to 15 percent imperviousness. [6]

[6] Galli, 1993

2.2 Impervious Coverage

Impervious surface coverage can be an important indicator of stream water quality and watershed health. Therefore, it is important to understand the typical percentage impervious surface coverage associated with various urban and suburban land uses. Table 2-1 below illustrates the estimated average surface coverage for common land use types.

Table 2-1: Typical Percent Impervious Coverage

LAND USE TYPE	IS COEFFICIENT
Single-Family Residential (1 to 10 acres) [a]	15
Single-Family Residential (< 1 acre) [a]	34
Multi-Family Residential, Group Quarters, Hotels [b]	68
Industrial [b]	91
Transportation [c]	100
Airports [c]	100
Commercial [b]	92
Office [c]	92
Hospital [c]	80
Military [b]	80
Schools [b]	80
Commercial Recreation [c]	91
Parks [b]	0
Agriculture [c]	0
Vacant	0
Water	0
Under Construction	0

[a] Based on 2002 impervious surface pilot study in the San Diego River Watershed conducted by DPLU-GIS.

[b] Adopted from Wong et al. (1997), Los Angeles County Department of Public Works, Santa Monica Bay Drainage Study

[c] Adopted from Sleavin et al. (2000), Measuring IS for Non-Point Source Pollution Modeling

Most developed land uses exceed the threshold of 10 to 15 percent impervious cover, which define healthy watershed or stream system. It may initially appear from this table that dispersed development would be

desirable, perhaps lots on one or two acres with scattered commercial areas, as it results in the lowest percentage of impervious surface coverage. However, on a regional or watershed level, greater overall water quality protection is achieved through more concentrated development. Under the "sprawl" scenario, development is spread over a much broader area, and additional impervious area, in the form of roads, would be needed to link dispersed communities together. Therefore, the best way to minimize impervious surface on a watershed level is to concentrate or cluster development in existing village centers or high-density clusters.[7] A clustered approach will decrease the overall impervious cover, resulting in greater protection for the overall watershed, as a much larger percentage of the watershed will be left in its natural condition, preserving water quality. In addition, such centralized development can be directed away from sensitive areas such as stream banks to minimize the negative impact on water quality. Using a variation of the clustering approach, development with high imperviousness would be directed to the existing urban and suburban watersheds, and low impervious development would be focused in the existing open space watersheds.

Reducing impervious cover and utilizing impervious coverage thresholds for watershed management can also save money. Roads and sidewalks and other infrastructure can account for over half the cost of a subdivision.[8] If a 32-foot wide roadway were narrowed to 30 feet, the savings would be up to $100 per linear foot or up to $528,000 per mile.[9] Reducing the imperviousness of a new development not only benefits the environmental health of streams and watersheds, but it would also result in economic savings by the development community.

[7] Schuler, Thomas. 1994
[8] CH2M-Hill, 1993)
[9] Schuler, Thomas, 1997

3.0 Impervious Coverage Thresholds – The Concept

AN ARTICLE PUBLISHED by the Center for Watershed Protection divided urban land uses into three categories based upon impervious cover.[10] In watersheds with low pollutant potential of less than 10 percent impervious coverage, the goal is to protect water quality with an emphasis on preservation and protection of open, natural space. In watersheds with a medium pollution potential of 10 to 20 percent, the goal is to limit degradation of water quality with zoning techniques and Best Management Practices. Finally, in areas of high pollutant potential exceeding 20 percent impervious, redevelopment should be encouraged.

3.1 Watershed Development Districts

Building upon this watershed philosophy, the Department is advocating the use of impervious surface coverage as a measurable indicator to guide development in the sensitive watersheds of San Diego County. An analysis of the existing impervious surface areas must be conducted based on natural watershed boundaries. Once mapped, Watershed Development Districts are established that prioritize either "preservation" or "restoration" areas (Figure 3-1). Once identified, maximum percent impervious thresholds can be established for each district.

3.1.1 Preservation Areas

Preservation Areas would be designed to protect streams of existing good water quality and have the following characteristics:

- Relatively high percentages of wooded land and open space (>30 percent)
- Relatively low percentages of urban/suburban land uses with low amounts of impervious cover (<15 percent)
- Relatively few contaminated sources such as hazardous waste sites and wastewater discharges
- Relatively good water quality, which supports the beneficial uses

Development occurring within the Preservation Watershed District shall not exceed 15 percent impervious cover per parcel

[10] Schueler, Thomas. 1996

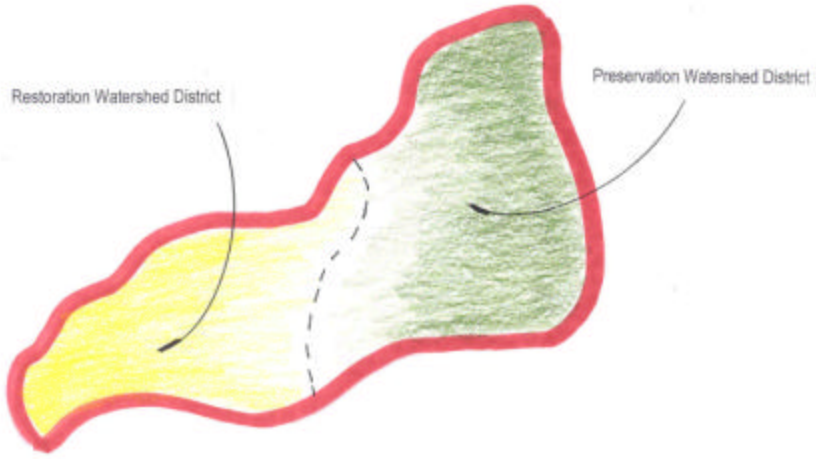
3.1.2 Restoration Areas

Restoration Areas would be designed to restore poor stream water quality and have the following characteristics:

- Relatively low percentages of wooded land and open space (<30 percent)
- Relatively high percentages of urban/suburban land uses with low amounts of impervious cover (>15 percent)
- Relatively high densities of contaminant sources such as wastewater discharges
- Relatively poor water quality, which is impaired

Development occurring within the Restoration Watershed District shall not exceed 50 percent impervious cover per parcel.

Figure 3-1: Watershed Development Districts



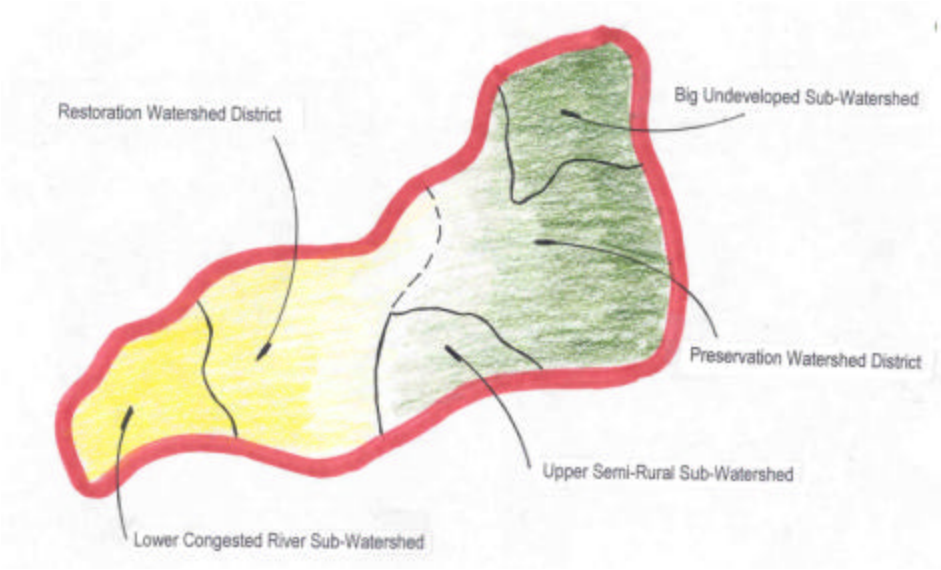
This establishment of Watershed Development Districts is only the first step in establishing impervious surface factors for new development. Recognition must be given to those sub-watersheds or hydrologic units that currently exceed the 50 percent impervious cover requirement for restoration areas or are significantly below the 15 percent impervious cover requirement for preservation areas. Sub-Watershed Development Districts are needed in order to establish "specialized" impervious cover factors that are unique to these smaller areas (Figure 3-2). The following parameters (or "zones') could be followed when establishing impervious cover factors for these focused areas:

- **Urban Growth** and redevelopment would be concentrated and focused in the already developed watersheds where the impervious surface coverage exceeds 40 percent. The focus is to enact development policies that encourage retrofitting to restore water quality – incentives are provided to focus redevelopment and stormwater retrofitting along urban waterways.

- **Suburban Growth** would be applied in the watersheds with 16 to 40 percent impervious coverage. The focus, again, is to enact development policies that encourage retrofitting to restore water quality. Suburban growth areas would be prioritized to acquire and protect the remaining undeveloped lands. Suburban growth would be directed toward the watershed with existing impervious coverage of 16 to 40 percent provided that rooftop and pavement area of the development does not exceed this threshold.

- **Open Space** acquisition and conservation would be applied within the relatively undeveloped watersheds where the impervious surface coverage is below 15 percent. These "green" open space watersheds would have low intensity development designed to protect the existing good water quality. Pursuant to this 'zone', new development would be permitted in the watershed identified for open space preservation provided the gross impervious coverage at build out does not exceed 10 top 15 percent.

Figure 3-2: Sub-Watershed Development Districts



A GIS database could be used to track the gross impervious cover amounts based upon accumulations in developed land uses in a particular 'zone'. As the gross impervious cover of a watershed reaches the threshold, growth could be directed towards other watersheds, which could accommodate the development. An example of a threshold table for these smaller sub-watersheds can be found in Table 3-1 below.

Table 3-1: Example Threshold Table for Sub-Watersheds

Sub-Watershed Name	Area (sq. mi.)	Existing % Impervious Cover	Maximum % Impervious Cover Threshold	Development "Zone'
Big Undeveloped	70.1	8	10	Open
Upper Semi-Rural	25.2	30	34	Suburban
Lower Congested River	35.6	55	60	Urban

An example of how this concept may be presented as a development condition is below:

> *" The applicant shall record impervious cover calculations of rooftop and pavement areas on the development plans. Development occurring within the Preservation Watershed District shall not exceed 15 percent impervious cover per parcel. Development occurring within the Restoration Watershed District shall not exceed 50 percent impervious cover per parcel. Development occurring within Big Undeveloped, Upper Semi-Rural or the Lower Congested River sub-watersheds shall not exceed the impervious factors outlined in Table 3-1. "*

To assist in compliance, the program could provide guidance on various techniques that can be used to minimize impervious cover in new and retrofitted developments:

? Narrower residential streets
? Smaller turn-around and cul-de-sac radii
? Smaller parking demand ratios
? Angled one way parking
? Smaller front yard setbacks
? Shorter road lengths
? Permeable paving for parking areas
? Smaller Parking stalls
? Clustered subdivisions
? Shared parking and driveways

To provide flexible development options, the program could contain stormwater credits that permit the impervious cover thresholds to be increased at no more than 5 percent for successful incorporation of certain techniques, such as:

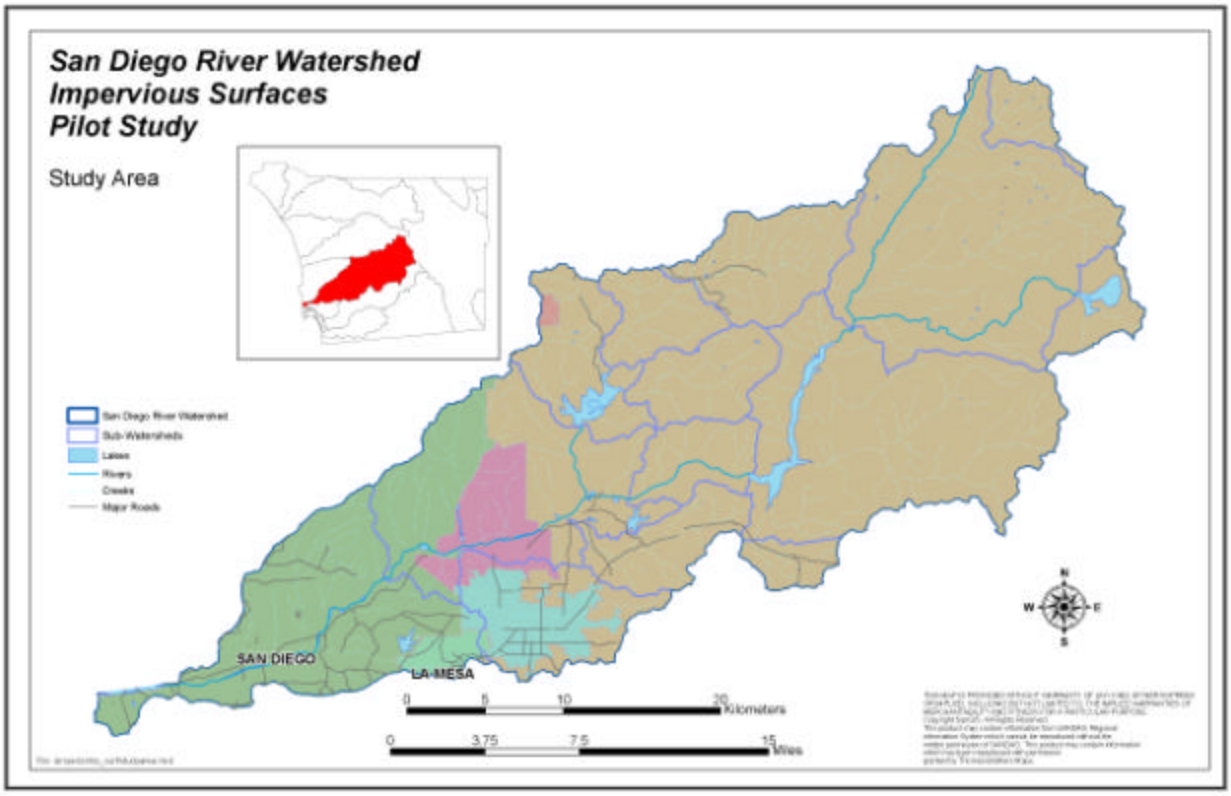
- Disconnection of rooftop runoff splash onto lawns or infiltrate into the groundwater table
- Revegitation of disturbed areas along riparian stream corridors
- Removal of impervious surfaces from onsite or from other watersheds
- Acquisition and protection of open space offsite through conservation easements.

4.0 San Diego River Watershed – A Case Study

4.1 Watershed Description

THE SAN DIEGO RIVER WATERSHED is the fourth largest hydrologic unit in the San Diego region with a land area of approximately 434 square miles. The San Diego River itself travels for approximately 52 miles through the center of the watershed from its headwaters in the mountains near Julian to the Pacific Ocean. The San Diego River and its many tributaries function as the main drainage channels for the watershed. The major water bodies found within the watershed include San Diego River, El Capitan Reservoir, San Vicente Reservoir, Lake Murray, Boulder Creek, Santee Lakes, Lake Jennings, Cuyamaca Reservoir. The watershed contains portions of the cities of San Diego (16.9%), El Cajon (3.3%), La Mesa (1.1%), Poway (0.2%) and Santee (3.8%) as well as unincorporated area of the County (74.7%). The San Diego River watershed can be divided into 14 sub-watersheds, which are shown in Figure 4-1 below.

Figure 4-1: San Diego River Watershed



While the watershed has been considerably altered as a result of urbanization, agriculture and mining operations, it is still considered rich in biological resources (Figure 4-2 and Table 4-1). Important hydrologic resources in the watershed include five water storage reservoirs, a large groundwater aquifer, extensive riparian habitat and coastal wetlands. Sensitive species that can be found within the watershed include

Coastal Cactus, Cuyamaca Cypress, California gnatcatcher, Least Bell's Vireo, Cooper's hawk, Orange-throated whiptail, Arroyo Toad and California Least Tern. The Cleveland National Forest and Mission Trails Regional Park are two important watershed resources that support a wide variety of these habitats and sensitive species.

Figure 4-2: San Diego River Watershed Land Use Classifications

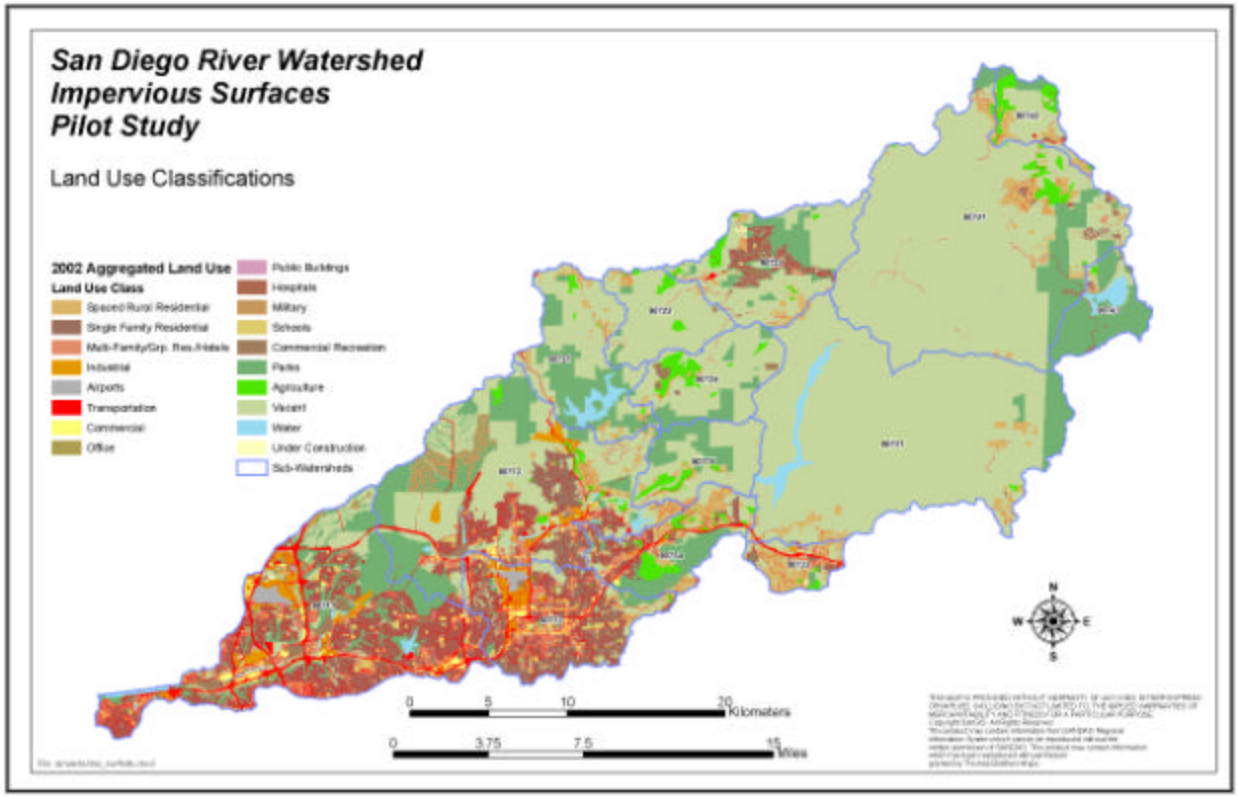


Table 4-1: Land Use Distribution

Land Use	% Of Watershed
Residential	17.4
Commercial	1.5
Industrial	1.4
Public Facilities/Utilities	3.9
Parks and Recreation	15.0
Agriculture	2.3
Undeveloped	57.0
Water Bodies	1.5

The lower portion of the San Diego River watershed is generally typical of urbanized coastal areas in Southern California and contains some of the more intensely urbanized areas of the county. While a significant portion of the upper and eastern portion of the watershed remains undeveloped, the watershed faces considerable urbanization pressures typical of the Southern California region. Communities found within the upper reaches of the watershed include Lakeside, Alpine, Descanso and Julian.

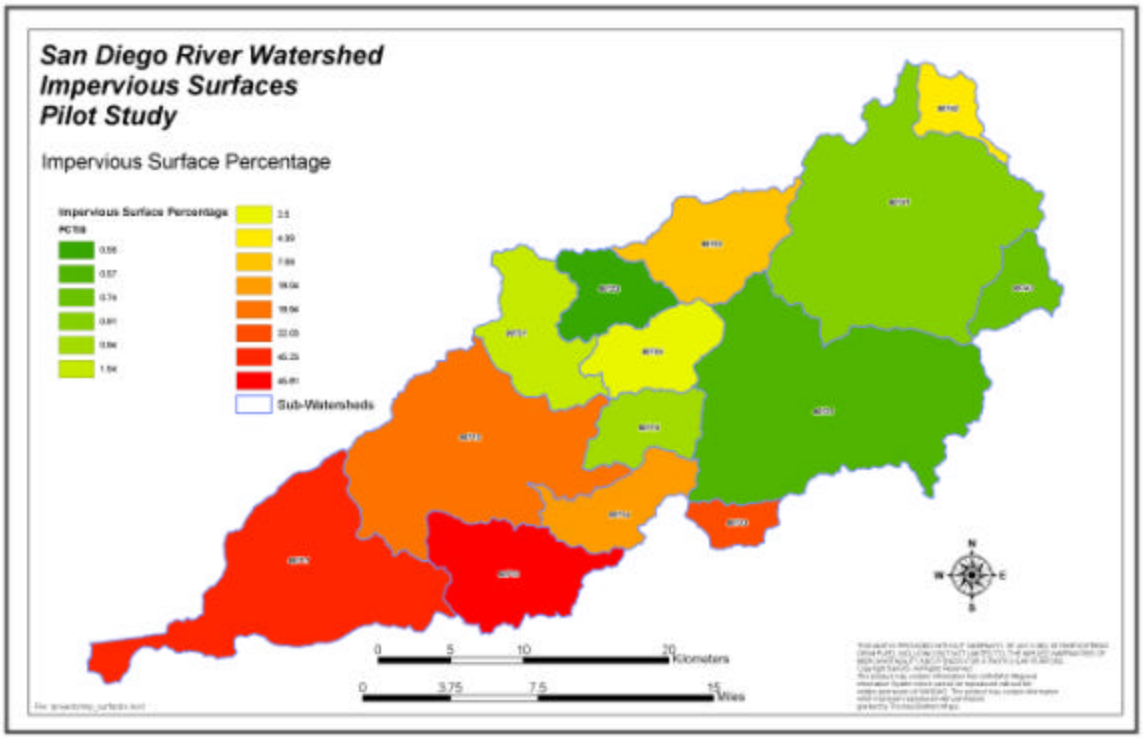
Due to excessive development, habitat degradation and loss, invasive species and flooding, the watershed suffers from the following water quality problems:

- Famosa Slough & Channel (Eutrophication);
- Forester Creek (fecal coliform, Ph, TDS);
- Pacific Shoreline (bacteria);
- Lower San Diego River (fecal coliform, phosphorus, TDS, low dissolved oxygen, TDS)

4.2 San Diego River Watershed Development Districts

Using the impervious surface coefficients identified in Table 2-1 of this report, the Department was able to estimate the current impervious cover for each of the sub-watersheds in San Diego River (Figure 4.3).

Figure 4.3: San Diego River Impervious Surface Percentages by Sub-Watershed [11]



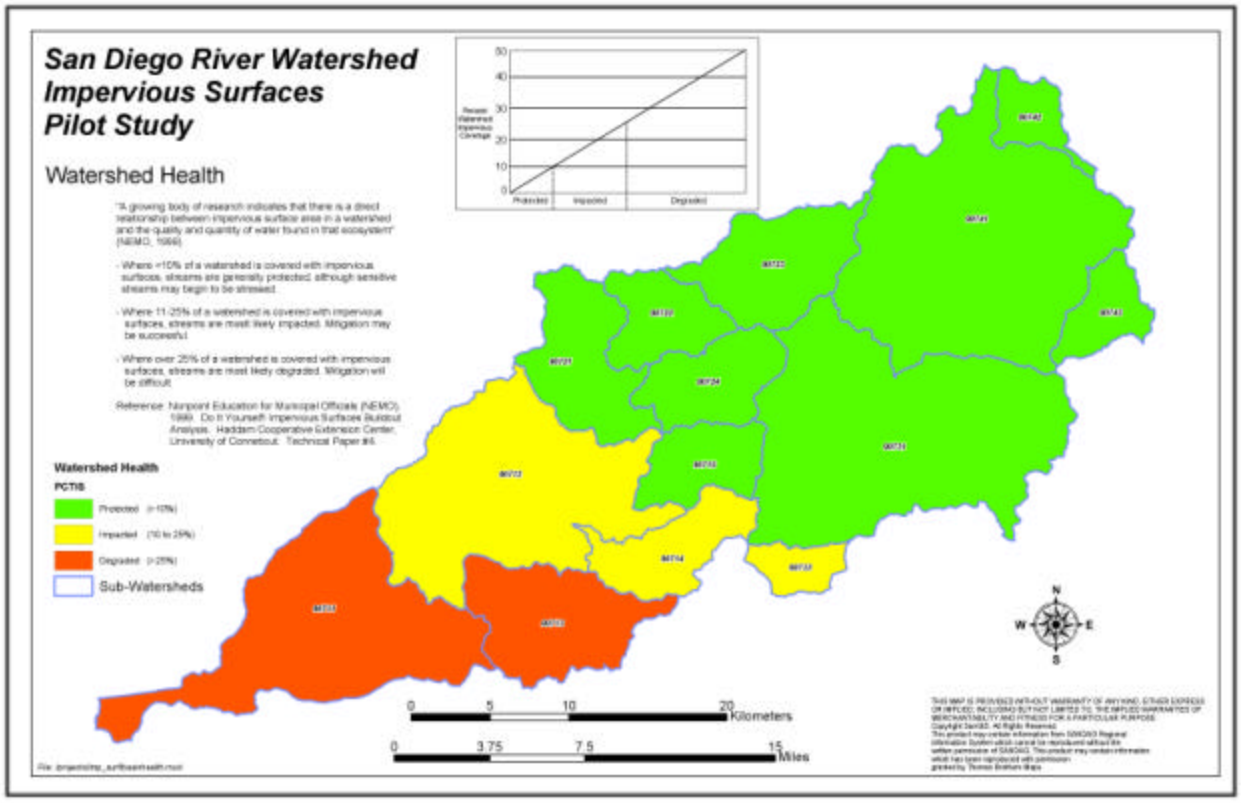
There should be no surprise that the central and headwaters of the watershed reflect the lowest impervious surface percentages – these areas have seen relatively limited growth and there are currently large land tracts that are permanently protected from future development (e.g. Cleveland National Forest, Multiple Species Conservation Program area, etc.). The lower watersheds, on the other hand, reflect impervious

[11] Explanation for elevated impervious surface percentages in certain sub-watersheds: 90724 (Barona/Lakeside); 90723 (Ramona); 90733 (Alpine); and, 90742 (Julian).

surface percentages typical of developed cities, which are expected given that the cities of San Diego, El Cajon, Santee and La Mesa are found within these areas.

Applying the impervious cover thresholds concept described in Section 3 of this report to this case study, Watershed Development Districts can be clearly established for the San Diego River watershed. As shown in Figure 4-4, the watershed can be divided into two districts: Preservation Areas (green) and Restoration Areas (red and yellow). The Preservation Areas, which would protect areas of good water quality, would limit impervious surface coverage for new development to 15 percent or less. Restoration Areas, which would promote restoration and reduction of impervious surfaces, would limit impervious cover on new and redevelopment projects to 50 percent or less.

Figure 4-4: Watershed Development Districts – San Diego River



However, the Department recognizes that there are certain sub-watersheds that require specific impervious cover thresholds due to their unique existing conditions. Specially, sub-watersheds 90731 and 90741, which are located in the Preservation Area, drain into the EL Capitan reservoir and currently have an impervious surface percentage of less than 1 percent. Conversely, the impervious coverage in sub-watersheds 90711 and 90713, which are located in the Restoration Area, are already close to 50 percent. As such, thresholds for these sub-watersheds will need to be designed specifically to address theses existing circumstances (Table 4-3).

Table 4-3: Conceptual Threshold Table for Sub-Watersheds

Sub-Watershed Development District	Existing % Impervious Cover	Maximum % Impervious Cover Threshold [a]	Development "Zone'
Sub-Watershed 90741	0.94	TBD	Open
Sub-Watershed 90731	0.57	TBD	Open
Sub-Watershed 90713	45.23	TBD	Urban
Sub-Watershed 90711	45.81	TBD	Urban

[a] Maximum impervious cover thresholds for the sub-watersheds requires further analysis of the area and agreement between the municipalities.

Each jurisdiction will be responsible for tracking the gross impervious cover amounts based upon accumulations in developed land uses in their sub-watersheds. As the gross impervious cover of a watershed reaches the threshold, jurisdictions could direct growth towards other sub-watersheds that are under their authority, which could accommodate the additional development.

5.0 Implementation

A CITY'S LAND USE AUTHORITY, or ability to regulate land use development, does not extend beyond the jurisdiction's boundaries; cities are autonomous and cannot dictate or mandate local solutions to another municipality. However, since the application of impervious cover thresholds and Watershed Development Districts span across the entire watershed, cities and counties must find a way to uniformly implement the program in order for the strategy to be successful.

The first step in developing/implementing a Watershed Development District program is a formal agreement between the municipalities. A formal agreement acknowledges that there is a need for action and willingness on the part of the participants to implement a program. Through an agreement, municipalities can establish how they will apply their common powers towards a common goal, while still maintaining their complete autonomy.

There are many forms of agreements that can be used to implement a Watershed Development Districts program (e.g. Joint Exercise of Powers Agreement, Memorandum of Understanding, Memorandum of Agreement, etc.). Using a Joint Exercise of Powers Agreement (JEPA) as an example, the following is how a formal agreement can be structured to develop and implement a watershed program.

The purpose of a JEPA is not to create an independent agency, but rather a Policy Committee that is made up of equal representation from each of the jurisdictions with land use authority in the watershed. The Policy Committee, who has approval authority over the program, creates, and provides direction to, a Project Team that is responsible for the overall development of the watershed program. A stakeholder committee is often established as part of the JEPA to provide a forum for public input to both the Policy Committee and Project Team.

Most importantly, a JEPA establishes the operational framework in which the jurisdictions and stakeholders interact. Without clear guidelines on limitations, expectations and responsibilities, working groups with the best intentions will often fail because of misunderstandings and an inability to resolve conflicts. A JEPA provides guidelines and parameters, which are needed for program development (e.g. how meetings are conducted, how a quorum is established, conflict resolution, withdrawal from the agreement, etc.) and program implementation. It must be emphasized that a JEPA does not impinge upon local land use authority, nor does the instrument mandate local solutions. A JEPA is nothing more than a vehicle to facilitate joint planning efforts, with each local government retaining complete autonomy.

6.0 Going Forward

ALTHOUGH SIGNIFICANT STRIDES have been made in the development of this program, additional resources and analysis are going to be needed before the strategy can be rolled out to the municipalities for consideration. Below is a summary of some of the immediate issues that need to be resolved before Department can take that next step in execution.

6.1 Mapping Impervious Surfaces

Improvements to the modeling effort are needed in order to increase the accuracy of the impervious surfacing mapping. The Department of Planning and Land Use's research product entitled "Mapping Impervious Surfaces in the Upper San Diego River Watershed," provides a solid foundation for estimating the average proportion of hardscape in the San Diego River watershed. However, the study was only conducted for single-family residential land use categories located within a small segment of the San Diego River Watershed. In order to accurately identify the current impervious percentages of the watershed and sub-watersheds as well as establish appropriate maximum impervious cover factors, the following is needed:

- The Mapping Impervious Surfaces in the Upper San Diego River Watershed study area must be expanded. In order for the impervious surface coefficients to be statistically significant and representative of the entire watershed, the study area needs to be expanded to include sample areas within the incorporated cities as well as rural unincorporated county.

- The Mapping Impervious Surfaces in the Upper San Diego River Watershed project needs to include additional land use categories such as commercial and industrial. The coefficients used in the case study are largely based on studies conducted in Los Angeles. Since land use development philosophies and patterns differ significantly between LA and San Diego, it is important to establish coefficients that best reflect the San Diego region.

DPLU GIS estimates that an additional $37,000 is needed to expand the study area to include the additional land use types and to make the figures scientifically significant. A breakdown of the costs can be shown in Table 6-1 below.

Table 6-1: Cost Estimate to Develop Impervious Surface Coefficients for SD County

COMPONENT	COST
Research & Development - Review Pertinent Literature - Methodology Refinement	$2,000
Data Pre-processing - Land use - Parcels	4,000
Software Acquisition - VLS Feature Analyst (1 Year Subscription)	2,500
Image Acquisition/Pre-processing - Mosaicking - Spectral Enhancement	5,000
Data Processing/Modeling - Feature Analyst - Training Sites - Model Development - Model Refinement - Model Output Analysis	8,000
Field Work - Ground Truthing/Field Verification of Results - Random Sample Generation - Field Map Creation - Site Visits (200+ Sites*)	6,000
Data Post-processing - Accuracy Assessment (Kappa Statistic) - I.S. Coefficient Development - Descriptive Statistics - Document Creation	9,500
ESTIMATED TOTAL COST	**$37,000**

6.2 Acceptance by other Jurisdictions

The Watershed Development District program needs to be embraced by the municipalities with land use authority in San Diego River. Otherwise, staff resources and funds will be unproductively spent on another "theoretical" project that sits in a file and never sees the light of

day. A campaign must be created and implemented by the County to try and solicit support from the municipalities for this project. DPLU recommends that once statistically supportable coefficients area established (as discussed in 6.1) and the white paper updated, the program be released to the planning directors in the cities of Santee, El Cajon, La Mesa and San Diego to get their initial thoughts on the concept. Follow-up meetings with those directors will then need to be conducted in order to listen to their concerns and comments. The outcome of those follow-up meetings will dictate how the Department will proceed with the program.

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